CLAIMS

I/WE CLAIM:

1. A gas discharge laser crystallization apparatus for performing a transformation of a crystal makeup or orientation in the substrate of a workpiece comprising:

a multichamber laser system comprising:

a first laser unit comprising:

a first gas discharge chamber;

a first pair of elongated spaced apart opposing electrodes contained within the first chamber, forming a first elongated gas discharge region;

a laser gas contained within the first chamber comprising a halogen and a noble gas selected to produce laser light at a center wavelength optimized to the crystallization process to be carried out on the workpiece;

a second laser unit comprising:

a second gas discharge chamber;

a second pair of elongated spaced apart opposing electrodes contained within the second chamber, forming a second elongated gas discharge region;

a laser gas contained within the second chamber comprising a halogen and a noble gas selected to produce laser light at a center wavelength optimized to the crystallization process to be carried out on the workpiece;

a power supply module comprising:

a DC power source;

a first pulse compression and voltage step up circuit connected to the DC power source and connected to the first pair of electrodes comprising a multistage fractional step up transformer having a plurality of primary windings connected in series and a single secondary winding passing through each of the plurality of primary windings, and a solid state trigger switch; and

a second pulse compression and voltage step up circuit connected to the DC power source and connected to the second pair of electrodes comprising a multistage fractional step up transformer having a plurality of primary windings connected in series and a single secondary winding

passing through each of the plurality of primary windings, and a solid state trigger switch; and

a laser timing and control module operative to time the closing of the respective solid state switch based upon operating parameters of the respective first and second pulse compression and voltage step up circuit to effect operation of the first and second laser units as either a POPA configured laser system or a POPO configured laser system to produce a single output laser light pulse beam.

2. The apparatus of claim 1 wherein the laser system is configured as a POPA laser system and further comprising:

relay optics operative to direct a first output laser light pulse beam from the first laser unit into the second gas discharge chamber; and,

the timing and control module times the closing of the second solid state switch based, in part, upon the time of the closing of the first solid state switch to create a gas discharge between the second pair of electrodes while the first output laser light pulse beam is transiting the second discharge region, within plus or minus 3 ns, to produce a second amplified laser output light pulse beam as the single output laser light pulse beam.

3. The apparatus of claim 1 wherein the laser system is configured as a POPO laser system and further comprising:

combining optics operative to combine a first output laser light pulse beam from the first laser unit with a second output laser light pulse beam from the second laser unit to produce the single output laser light pulse beam; and

the timing and control module times the closing of the second slid state switch based, in part, upon the time of the closing of the first solid state switch to create a gas discharge between the second pair of electrodes to separate an output laser light pulse in the first output laser light pulse beam from an output laser light pulse in the second output laser light pulse beam in the single output laser light pulse beam by a preselected time plus or minus 3 ns.

4. The apparatus of claim 1, further comprising:

a pulse stretcher in the path of the single output laser light pulse beam operative to stretch the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

5. The apparatus of claim 2, further comprising:

a pulse stretcher in the path of the single output laser light pulse beam operative to stretch the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

6. The apparatus of claim 3, further comprising:

a pulse stretcher in the path of the single output laser light pulse beam operative to stretch the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

7. The apparatus of claim 1, further comprising:

a beam delivery unit in the path of the single output laser light pulse beam and operative to deliver the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment module within the beam delivery unit comprising a beam parameter monitor and a beam parameter adjustment mechanism.

8. The apparatus of claim 2, further comprising:

a beam delivery unit in the path of the single output laser light pulse beam and operative to deliver the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment module within the beam delivery unit comprising a beam parameter monitor and a beam parameter adjustment mechanism.

9. The apparatus of claim 3, further comprising:

a beam delivery unit in the path of the single output laser light pulse beam and operative to deliver the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment module within the beam delivery unit comprising a beam parameter monitor and a beam parameter adjustment mechanism.

10. The apparatus of claim 4, further comprising:

a beam delivery unit in the path of the single output laser light pulse beam and operative to deliver the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment module within the beam delivery unit comprising a beam parameter monitor and a beam parameter adjustment mechanism.

11. The apparatus of claim 5, further comprising:

a beam delivery unit in the path of the single output laser light pulse beam and operative to deliver the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment module within the beam delivery unit comprising a beam parameter monitor and a beam parameter adjustment mechanism.

12. The apparatus of claim 6, further comprising:

a beam delivery unit in the path of the single output laser light pulse beam and operative to deliver the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment module within the beam delivery unit comprising a beam parameter monitor and a beam parameter adjustment mechanism.

13. The apparatus of claim 7 further comprising:

the timing and control module comprises a processor performing a programmed timing control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

14. The apparatus of claim 8 further comprising:

the timing and control module comprises a processor performing a programmed timing control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits

and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

15. The apparatus of claim 9 further comprising:

the timing and control module comprises a processor performing a programmed timing control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

16. The apparatus of claim 10 further comprising:

the timing and control module comprises a processor performing a programmed timing control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

17. The apparatus of claim 11 further comprising:

the timing and control module comprises a processor performing a programmed timing control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

18. The apparatus of claim 12 further comprising:

the timing and control module comprises a processor performing a programmed timing control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

19. A gas discharge laser crystallization means for performing a transformation of a crystal makeup or orientation in the substrate of a workpiece comprising:

a multichamber laser system comprising:

a first laser unit comprising:

a first gas discharge chamber;

a first pair of elongated spaced apart opposing electrodes contained within the first chamber, forming a first elongated gas discharge region;

a laser gas contained within the first chamber comprising a halogen and a noble gas selected to produce laser light at a center wavelength optimized to the crystallization process to be carried out on the workpiece;

a second laser unit comprising:

a second gas discharge chamber;

a second pair of elongated spaced apart opposing electrodes contained within the second chamber, forming a second elongated gas discharge region;

a laser gas contained within the second chamber comprising a halogen and a noble gas selected to produce laser light at a center wavelength optimized to the crystallization process to be carried out on the workpiece;

a power supply means comprising:

a DC power source;

a first pulse compression and voltage step up means connected to the DC power source and connected to the first pair of electrodes comprising a multistage fractional step up transformer having a plurality of primary windings connected in series and a single secondary winding passing through each of the plurality of primary windings, and a solid state trigger switch; and

a second pulse compression and voltage step up means connected to the DC power source and connected to the second pair of electrodes comprising a multistage fractional step up transformer having a plurality of primary windings connected in series and a single secondary winding passing through each of the plurality of primary windings, and a solid state trigger switch; and

a laser timing and control means for timing the closing of the respective solid state switch based upon operating parameters of the respective first and second pulse compression and voltage step up means for effecting operation of the first and second

laser units as either a POPA configured laser system or a POPO configured laser system to produce a single output laser light pulse beam.

20. The apparatus of claim 19 wherein the laser system is configured as a POPA laser system and further comprising:

relay optics means for directing a first output laser light pulse beam from the first laser unit into the second gas discharge chamber; and,

the timing and control means including means for timing the closing of the second solid state switch based, in part, upon the time of the closing of the first solid state switch to create a gas discharge between the second pair of electrodes while the first output laser light pulse beam is transiting the second discharge region, within plus or minus 3 ns, for producing a second amplified laser output light pulse beam as the single output laser light pulse beam.

21. The apparatus of claim 19 wherein the laser system is configured as a POPO laser system and further comprising:

combining optic means for combining a first output laser light pulse beam from the first laser unit with a second output laser light pulse beam from the second laser unit to produce the single output laser light pulse beam; and

the timing and control means including means for timing the closing of the second slid state switch based, in part, upon the time of the closing of the first solid state switch for creating a gas discharge between the second pair of electrodes to separate an output laser light pulse in the first output laser light pulse beam from an output laser light pulse in the second output laser light pulse beam in the single output laser light pulse beam by a preselected time plus or minus 3 ns.

22. The apparatus of claim 19, further comprising:

a pulse stretching means in the path of the single output laser light pulse beam for stretching the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

23. The apparatus of claim 20, further comprising:

a pulse stretching means in the path of the single output laser light pulse beam for stretching the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

24. The apparatus of claim 21, further comprising:

a pulse stretching means in the path of the single output laser light pulse beam for stretching the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

25. The apparatus of claim 19, further comprising:

a beam delivery unit means in the path of the single output laser light pulse beam for delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment means within the beam delivery unit means comprising a beam parameter monitoring means and a beam parameter adjustment means.

26. The apparatus of claim 20, further comprising:

a beam delivery unit means in the path of the single output laser light pulse beam for delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment means within the beam delivery unit means comprising a beam parameter monitoring means and a beam parameter adjustment means.

27. The apparatus of claim 21, further comprising:

a beam delivery unit means in the path of the single output laser light pulse beam for delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment means within the beam delivery unit means comprising a beam parameter monitoring means and a beam parameter adjustment means.

28. The apparatus of claim 22, further comprising:

a beam delivery unit means in the path of the single output laser light pulse beam for delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment means within the beam delivery unit means comprising a beam parameter monitoring means and a beam parameter adjustment means.

29. The apparatus of claim23, further comprising:

a beam delivery unit means in the path of the single output laser light pulse beam for delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment means within the beam delivery unit means comprising a beam parameter monitoring means and a beam parameter adjustment means.

30. The apparatus of claim 24, further comprising:

a beam delivery unit means in the path of the single output laser light pulse beam for delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

a beam adjustment means within the beam delivery unit means comprising a beam parameter monitoring means and a beam parameter adjustment means.

31. The apparatus of claim 25 further comprising:

the timing and control means comprises a processor means for performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up means and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up means.

32. The apparatus of claim 26 further comprising:

the timing and control means comprises a processor means for performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up means and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up means.

33. The apparatus of claim 27 further comprising:

the timing and control means comprises a processor means for performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up means and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up means.

34. The apparatus of claim 28 further comprising:

the timing and control means comprises a processor means for performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up means and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up means.

35. The apparatus of claim 29 further comprising:

the timing and control means comprises a processor means for performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up means and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up means.

36. The apparatus of claim 30 further comprising:

the timing and control means comprises a processor means for performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up means and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up means.

37. A method for performing a transformation of a crystal makeup or orientation in the substrate of a workpiece using a gas discharge laser comprising:

using a multichamber laser system comprising:

a first laser unit comprising:

a first gas discharge chamber;

a first pair of elongated spaced apart opposing electrodes contained within the first chamber, forming a first elongated gas discharge region;

a laser gas contained within the first chamber comprising a halogen and a noble gas selected to produce laser light at a center wavelength optimized to the crystallization process to be carried out on the workpiece;

a second laser unit comprising:

a second gas discharge chamber;

a second pair of elongated spaced apart opposing electrodes contained within the second chamber, forming a second elongated gas discharge region;

a laser gas contained within the second chamber comprising a halogen and a noble gas selected to produce laser light at a center wavelength optimized to the crystallization process to be carried out on the workpiece;

a power supply means comprising:

a DC power source;

a first pulse compression and voltage step up means connected to the DC power source and connected to the first pair of electrodes comprising a multistage fractional step up transformer having a plurality of primary windings connected in series and a single secondary winding passing through each of the plurality of primary windings, and a solid state trigger switch; and

a second pulse compression and voltage step up means connected to the DC power source and connected to the second pair of electrodes comprising a multistage fractional step up transformer having a plurality of primary windings connected in series and a single secondary winding passing through each of the plurality of primary windings, and a solid state trigger switch; and

timing the closing of the respective solid state switch based upon operating parameters of the respective first and second pulse compression and voltage step up means for effecting operation of the first and second laser units as either a POPA configured laser system or a POPO configured laser system to produce a single output laser light pulse beam.

38. The method of claim 37 wherein the laser system is configured as a POPA laser system and further comprising:

directing a first output laser light pulse beam from the first laser unit into the second gas discharge chamber; and,

timing the closing of the second solid state switch based, in part, upon the time of the closing of the first solid state switch to create a gas discharge between the second pair of electrodes while the first output laser light pulse beam is transiting the second discharge region, within plus or minus 3 ns, for producing a second amplified laser output light pulse beam as the single output laser light pulse beam.

39. The method of claim 37 wherein the laser system is configured as a POPO laser system and further comprising:

combining a first output laser light pulse beam from the first laser unit with a second output laser light pulse beam from the second laser unit to produce the single output laser light pulse beam; and

timing the closing of the second slid state switch based, in part, upon the time of the closing of the first solid state switch for creating a gas discharge between the second pair of electrodes to separate an output laser light pulse in the first output laser light pulse beam from an output laser light pulse in the second output laser light pulse beam in the single output laser light pulse beam by a preselected time plus or minus 3 ns.

40. The method of claim 37, further comprising:

stretching the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

41. The method of claim 38, further comprising:

stretching the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

42. The method of claim 39, further comprising:

stretching the T_{is} of the pulses in the single output laser light pulse beam by at least 2X.

43. The method of claim 37, further comprising:

using a beam delivery unit in the path of the single output laser light pulse beam delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

using a beam adjustment mechanism within the beam delivery unit comprising a beam parameter monitoring means and a beam parameter adjustment means to monitor and adjust a beam parameter.

44. The method of claim 38, further comprising:

using a beam delivery unit in the path of the single output laser light pulse beam delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

using a beam adjustment mechanism within the beam delivery unit comprising a beam parameter monitoring means and a beam parameter adjustment means to monitor and adjust a beam parameter.

45. The method of claim 39, further comprising:

using a beam delivery unit in the path of the single output laser light pulse beam delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

using a beam adjustment mechanism within the beam delivery unit comprising a beam parameter monitoring means and a beam parameter adjustment means to monitor and adjust a beam parameter.

46. The method of claim 40, further comprising:

using a beam delivery unit in the path of the single output laser light pulse beam delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

using a beam adjustment mechanism within the beam delivery unit comprising a beam parameter monitoring means and a beam parameter adjustment means to monitor and adjust a beam parameter.

47. The method of claim 41, further comprising:

using a beam delivery unit in the path of the single output laser light pulse beam delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

using a beam adjustment mechanism within the beam delivery unit comprising a beam parameter monitoring means and a beam parameter adjustment means to monitor and adjust a beam parameter.

48. The method of claim 42, further comprising:

using a beam delivery unit in the path of the single output laser light pulse beam delivering the single output laser light pulse beam to a manufacturing tool for the performance of the transformation of the crystal makeup or orientation in the substrate of the workpiece; and,

using a beam adjustment mechanism within the beam delivery unit comprising a beam parameter monitoring means and a beam parameter adjustment means to monitor and adjust a beam parameter.

49. The method of claim 37 further comprising:

performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

50. The method of claim 38 further comprising:

performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

51. The method of claim 39 further comprising:

performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

52. The method of claim 40 further comprising:

performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

53. The method of claim 41 further comprising:

performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.

54. The method of claim 42 further comprising:

performing a programmed timing and control operation based upon received signals representative of the charging voltage in the respective first and second pulse compression and voltage step up circuits and signals representative of the temperature of at least one magnetic switching element in the respective first and second pulse compression and voltage step up circuit.